Interdependence between US and European Military Spending: A Panel Cointegration Analysis (1988-2013)

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INTERDEPENDENCE BETWEEN US AND EUROPEAN MILITARY SPENDING: A PANEL COINTEGRATION ANALYSIS (1988-2013)

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Abstract

The aim of this paper is to study the interdependence of military spending between US and a panel of European countries in the period 1988-2013. The empirical estimation is based on a: (i) a unit root tests and a cointegration analysis; (ii) FMOLS and DOLS estimations. General results highlight that military spending of European countries is: (1) positively associated with US military spending and (2) negatively associated with average military spending of other European countries.

Keywords: Military Spending, interdependence, Panel Cointegration, Fully Modified OLS, Dynamic OLS.

Jel classification: H56; H63; F52;

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Introduction

The traditional model of demand for military expenditure developed in Smith (1980) presents military expenditure of a country as function of civilian output and of the 'strategic environment' which in turn is a function of military expenditures of other countries. In particular, the illustrative focus there was on the relationship between a superpower and other countries. Under the assumption that military expenditure of a superpower can be interpreted as a credible signal of threat, two behaviours could be envisioned: (i) free riding; (ii) leader/follower relationship. In the first case, the empirical association between military expenditures of a superpower and its allies turns to be negative because a country can 'free-ride' so reducing its contribution to the production of the public good of security. In the alternative case, a country is intended to 'follow' the leader so increasing the military expenditure. In fact, military expenditure of the superpower signals an increase in threat. The latter can be either allies or foes. Eventually, several papers confirmed the interdependence between the military spending of countries within an alliance at regional level [see among others Murdoch and Sandler (1984), Smith (1989), Sandler and Murdoch (1990)]. In this vein, this paper is intended first to verify whether the interdependence between US and European countries is confirmed in the period 1988-2013 when using a panel cointegration analysis. Then, by means of FMOLS and DOLS regressions, we provide long-run elasticities. In brief, we are able to verify whether European countries followed or free rode on US military spending. Secondly, we also consider interdependence among a panel of twenty European countries.

The data set

The empirical analysis exploits a panel of twenty European countries: Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania,

Spain, Sweden, Switzerland, Turkey and United Kingdom. With the exception of Finland, Ireland, Switzerland and Sweden all countries are members of NATO. The sample selection was driven by data availability. The panel includes 26 yearly observations from 1988 to 2013. The dependent variable is the level of military spending of country *i* in constant terms (*MilExp*). The main independent variables are: (i) the US military spending, namely *USMilExp*; (iii) the average military spending of other European countries considered, namely *EUMilExp*. According to the latter, when considering a country *i*, we compute *EUMilExp* as the average military spending of included European countries other than *i*. All the variables are expressed in constant prices (US dollars 2005) and logged. The data on Military Expenditure are drawn from the World Bank. Descriptive statistics of variables are in table 1.

TABLE 1 - Descriptive statistics of main variables .

	Obs.	Mean	Median	Std. Dev.	Min	Max
MilExp	520	27.095	26.953	1.361	23.319	29.467
EUMilExp	520	27.206	27.220	0.166	26.768	27.447
USMilExp	520	31.400	31.387	0.230	31.096	31.781

The empirical strategy and results

The empirical strategy is based on three steps: i) a panel unit root test on the variables; ii) a panel cointegration test; iii) FMOLS and DOLS estimations to capture the long-run relationships. Table 2 shows individual and common panel unit root test results based on Levin, Lin and Chu (LLC, 2000), Breitung and Meyer (BM, 1994), and Im, Pesaran and Shin (IPS, 2003).

TABLE 2. Panel Unit Roots Test

	No intercept and trend	Intercept	Intercept and trend
	Statistic	Statistic	Statistic
LLC			
MilExp	-1.667**	-4.403***	-2.305**

EUMilExp	23.174	-8.030***	7.717
USMilExp	0.979	-0.796	-3.414***
Δ MilExp	-22.247***	-19.489***	-16.801***
Δ EUMilExp	-10.724***	-14.418***	-13.386***
Δ USMilExp	-10.633***	-3.361***	-1.002
IPS			
MilExp		-3.485***	-2.375***
EUMilExp		-1.836**	9.147
USMilExp		1.526	-0.465
Δ MilExp		-19.121***	-16.134***
Δ EUMilExp		-10.643***	-9.157***
Δ USMilExp		-4.210***	-0.501
BM			
MilExp			-4.388***
EUMilExp			6.752
USMilExp			1.929
Δ MilExp			-8.390***
Δ EUMilExp			-14.067***
Δ USMilExp			-2.281**

Automatic selection of maximum lags based on Schwarz Info Criterion. Newey-West automatic bandwith selection and Bartlett kernel. ***, **, * indicate statistical significance at 1, 5 and 10 percent level of significance.

Results suggest that we can rarely reject the hypothesis of common and individual unit roots when the variables are in (logged) levels, while the hypothesis of stationarity holds for their first difference in nearly every case. The series are non-stationary in levels and stationary in first differences if no linear trend is modelled. In that case time series show a pure stochastic trend with individual intercept. Once tested that the variables are integrated of order one - I(1) - we eventually test the hypothesis of the presence of cointegrating relationships among the series. We conduct the Pedroni (1999) and the Kao (1999) residual cointegration tests assuming no deterministic time trend. The first rejects the null hypothesis of no cointegration (at 90%) for all out of 11 statistics reported in the case of pure stochastic trend and individual intercepts (10 out of 11 at 95%). On the contrary, the hypothesis of no cointegration is not rejected in all out of 11 tests, when no individual intercept and trend is modelled. According to the first trend specification, the Kao test suggests that cointegrated relationships exist among variables and a long run relationship may be estimated. Results of cointegration tests are shown in table 3.

TABLE 3. PANEL COINTEGRATION TEST.		
Variables: *MilExp, EUMilExp, USMilExp*		
Sample 1988-2013. Observations: 520 - Cross-sections included: 20. Trend assumption: no linear trend. Null Hypothesis: no cointegration		
Pedroni		
Alternative hypothesis: common AR coefs. (within-dimension)		
	Intercept	**No intercept and trend**
v-Stat	-2.696***	-2.141
rho-Stat	-1.627*	2.114
PP-Stat	-2.939***	1.369
ADF-Stat	-3.397***	1.413
	Weighted stat	**Stat**
v-Stat	2.072**	-2.919
rho-Stat	-4.223***	2.566
PP-Stat	-6.262***	2.232
ADF-Stat	-3.974***	2.447
Alternative hypothesis: individual AR coeffs. (between-dimension)		
	Stat	**Stat**
rho-Stat	-1.978**	3.933
PP-Stat	-5.471***	3.374
ADF-Stat	-6.566***	3.241
Kao		
	t-Stat	
ADF	-3.570***	
Automatic lag length selection based on Schwarz Info Criterion with a max lag of 5 - Newey-West automatic bandwidth selection and Bartlett kernel.		

The hypothesis of cointegrated relationships suggests us to estimate long period relationships between the variables by means of group-mean panel fully modified (FMOLS) and panel dynamic (DOLS) techniques as proposed by Pedroni (2000, 2001). Then, we estimate the following equation:

$$MilExp_{it} = \beta_{0i} + \beta_1 EUMilExp_{it} + \beta_2 USMilExp_t + \sum_{j=-k}^{k} \gamma_{ij} \Delta EUMilExp_{i,t-j} + \sum_{j=-k}^{k} \delta_{ij} \Delta USMilExp_t + e_{it},$$

where $MilExp$ is the military spending of *i-th* country, $EUMilExp$ and $USMilExp$ are the average military spending of other European countries and United States respectively. β_1 and β_2 are the parameters summarizing

the long run panel cointegrated relationships among the variables, while for DOLS specification γ_{ij} and δ_{ij} are coefficients of current, lead and lag differences accounting for potential serial correlation and endogeneity of regressors. Tables 4 shows the results.

TABLE 4. Dependent variable: *MilExp*.

	FMOLS	**DOLS**
EUMilExp (logged)	**-0.303*** **	**-0.213*** **
USMilExp (logged)	**0.161*** **	**0.157*** **
Observations	500	485
Periods	25	25
Cross-sections	20	20

Grouped estimation using differenced data. Individual intercept specification. Long run covariances option: Prewhitening with lags=-1 selected by SIC, maxlags=-1, Bartlett kernel, Newey-West fixed bandwidth. DOLS estimate: automatic leads and lags specification based on SIC criterion.

Results highlight a negative association between military spending among the European countries included in the panel, and a positive association with US military spending. Results are not sensitive to the estimation techniques, since coefficients estimated by FMOLS and DOLS are similar.
Coefficients are to be interpreted as punctual elasticities: (i) an increase of 1% in average European military spending translates into a decrease of the military spending of the *i-th* country between 0.2% and 0.3% in the long-run; (ii) an increase of 1% in US military spending translates into an increase of the military spending of the *i-th* country of 0.16%. The first result suggests that within Europe each country has benefited from military spending of other countries whereas the latter supports the mechanism 'leader/follower' with respect to US.

Reasonably countries can react differently. The table 5 below shows cointegration coefficients and their statistical significance for each country included in the panel. Some of them are worth noting: (i) not surprisingly UK appears to be a follower of US superpower. The long-run elasticity is 0.6; (ii) former eastern countries (Hungary and Romania) exhibit a high and positive association with US military spending. This perhaps also depends on former USSR influence; (iii) most European countries are followers of US. Only Ireland, Sweden and Turkey appear to free ride on US; (iv) most European countries react negatively to an increase of average spending of other European countries. Only Finland, Portugal, Ireland and Luxembourg do exhibit a positive coefficient.

TABLE 5. Coefficients for each country

	FMOLS		**DOLS**	
	EUMilExp	*USMilExp*	*EUMilExp*	*USMilExp*
Belgium	-1.321***	0.445***	-1.137***	0.350**
Denmark	-0.010	-0.023	0.032	-0.037
Finland	0.255*	0.316***	0.196	0.332***
France	-0.265***	0.168***	-0.285***	0.193***
Germany	-1.077***	0.471***	-0.809***	0.342***
Greece	0.237	-0.035	0.669*	-0.231
Hungary	-2.668***	0.830***	-1.666***	0.563**
Ireland	0.917***	-0.287**	0.804***	-0.287***
Italy	0.014	-0.092	0.103	-0.109
Luxembourg	1.297***	-0.123	1.175***	0.039
Netherlands	-0.752***	0.357***	-0.654***	0.400***
Norway	-0.382***	-0.076	-0.467***	-0.070
Poland	1.469***	0.183*	1.702***	0.093
Portugal	0.276***	0.112**	0.177**	0.160***
Romania	-2.943***	0.777***	-2.728***	1.067***
Spain	-0.630***	0.478***	-0.328	0.380***
Sweden	-0.438***	-0.193***	-0.429***	-0.153***
Switzerland	-1.096***	0.027	-1.143***	0.100**
Turkey	1.806***	-0.729***	1.280***	-0.612***

United Kingdom	-0.744***	0.607***	-0.762***	0.610***

Conclusions

The results highlight a positive interdependence between US and European military spending. Our estimates reveal that from the military spending perspective, the debate on the leader/follower relationships between United States and European countries is no longer uncertain. In fact, most European countries do behave as followers in the period 1988-2013. When considering coefficients for each country, it appears that the only remarkable exception is Turkey. In addition, within Europe the negative relationship seems to suggest that countries have exploited some form of burden sharing in defence.

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